DISARMAMENT

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New trends in science and technology
Implications for international peace and security

United Nations

Preface

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As part of the programme's activities, the Department for Disarmament Affairs provides information materials on arms limitation and disarmament issues to the non-specialized reader. Such materials cover, in an easily accessible style, issues which may be of particular interest to a broad public. This is one such publication. It is published in the official languages of the United Nations and intended for world-wide dissemination free of charge.

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Background

In December 1988, the General Assembly requested the Secretary-General to follow future scientific and technological developments, especially those with potential military applications, and to evaluate their impact on international security. In resolution 43/77 A it also requested the Secretary-General to report to it at its forty-fifth session.

The decision of the General Assembly was the result of an initiative by India. For those who supported it, qualitative aspects of the arms race were a cause for concern. They wanted serious consideration to be given to the establishment of mechanisms for monitoring new developments without targeting technologies or freezing the process of innovation. For those who had reservations on the issue, the field of scientific and technological developments appeared too vast and dynamic to be monitored in a meaningful way. They also took the position that technology was inherently dual-purpose.

To assist the Secretary-General in carrying out his mandate, a series of consultations were held with scientists, strategic analysts and policy-makers. The broad fields in which scientific and technological developments are taking place were identified as: information technology, biotechnology, materials technology, nuclear technology and space technology. Individual assessments in each of these fields were

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prepared by invited experts. These assessments were discussed by a wider group of experts at a high-level conference on "New trends in science and technology: implications for international peace and security", held in April 1990 in the city of Sendai, Japan.

The Conference, which was attended by nearly 100 participants from over 20 countries, addressed issues of technological change and global security, new technologies and the search for security in the post-cold-war era, and national policy-making and international diplomacy in an era of rapid technological change. General approaches to technology assessment and technology trends in selected areas were also discussed. The outcome of these discussions was included in the Secretary-General's report to the General Assembly at its forty-fifth session. The positions taken by Member States on the subject of establishing a mechanism for technology assessment were also taken into account. The highlights of the report are summarized below.

Highlights of the Secretary-General's report

With historic changes in United States-Soviet relations, new opportunities have opened up for the reduction, elimination and destruction of nuclear, chemical and conventional weapons. In this changed international environment, the concerns over the nature and direction of technological change are essentially twofold. First, there is an overriding anxiety lest modern technology should assist rather than hinder the positive trends in international relations. More specifically, there are concerns lest the application of new

technologies might result in continued qualitative development of nuclear weapons even as efforts are being made for their reduction and elimination. The use of new technologies for the qualitative modernization of conventional weapon systems could bring dramatic increases in their range, accuracy and lethality. Technological advances could also lead to the development of weapons based upon the application of advanced physical principles such as beam weapons.

A second, and more philosophical, concern is that significant aspects of modern technology do not address many of the pressing problems facing the world. While it is generally recognized that a diffusion of technologies would be instrumental in closing the economic gap between the industrialized and the developing countries, there are also doubts whether the international community is yet in a position to deal with some of the harmful side-effects of technological proliferation. Particularly pronounced in this respect are misgivings over the likely development and acquisition of nuclear, chemical and biological weapons by countries that do not at present adhere to the existing agreements for arms limitation. Apprehensions over the possible misuse of a combination of several available technologies by a national or sub-national group have been heightened by the persistence of tensions and unresolved conflicts in certain parts of the world.

Technology by itself does not threaten anyone. Efforts to steer the direction of technological changes can make progress only if the realities of contemporary life are taken into account. The current state of technological advancement represents decades

of cumulative knowledge that cannot be erased. It is also unrealistic to believe that the process of technological innovation can be frozen to prevent its military application. However, the very technologies capable of improving existing weapon systems can also often be used for their limitation, destruction or conversion. A few of the many areas in which militarily capable technologies could actually promote rather than threaten international security are the use of communication technologies for advance warning of impending conflicts, the employment of remote-sensing techniques for verification, and the development of appropriate techniques for ecologically safe methods of weapons disposal.

A number of new technologies are now in public view, which, if fully developed and deployed, could have implications for existing military capabilities.

Nuclear technology

After three or four decades of rapid growth, nuclear technology has matured and is now at a point where no new major breakthroughs seem likely in the near future. Current trends are largely extrapolations of past developments. Major steps in the development of fission explosive devices were taken even before the mid-1950s and no significant improvements are foreseen. The possibility of using uranium-233 as a weapons material was recognized long ago but does not seem to offer any substantial benefits. Concerns regarding the relationship between nuclear power and weapons proliferation have not been allayed, but the actual development has by no means followed earlier worst-case scenarios. Light-water reactors, fuelled with low-enriched uranium, are still prevalent

and will probably remain so throughout the 1990s. Projections of nuclear energy demands have been revised downwards repeatedly. Thus, to date, there has been no severe shortage of nuclear fuel, no large proliferation of enrichment or reprocessing facilities and no establishment of a "plutonium economy".

For the general public, environmental concerns play an important role. Those concerns have to do both with the possibility of serious accidents, such as the one at Chernobyl, and with radioactive waste management. Current development efforts in reactor technology are to a large extent related to safety.

Space technology

Since the first satellite was placed in orbit in 1957, space capabilities have developed essentially in four areas: space transportation, sensors, spacecraft and ground segment. Many of these capabilities are unique and cannot be duplicated by airborne or ground-based systems.

Military activities in space have been devoted to five traditional support missions: communications, reconnaissance and surveillance, navigation, meteorology and geodesy. The ease with which command and control can be exercised through satellite-based communications makes space-based systems very attractive for military commanders.

Broadly, the current trend in space and related technologies is towards the development of more effective satellite-based sensors, more survivable spacecraft and improved command and control systems. Both incremental advances and radical

improvements in any one or more of these areas could contribute towards a more efficient performance of the traditional military support missions in space. Technological advances have also opened up the possibilities for a host of future military missions in space. Among those envisaged, the following have frequently been debated: elaboration of space-based nuclear weapons capabilities; support to conventional forces; anti-satellite and satellite defence weapons; and space-to-Earth weapons.

Some of these hypothetical future technological possibilities are considered either technically fanciful or as addressing issues of peripheral military concern, not to mention the prohibitive costs. In order to be effective as space-based systems, the kinetic-energy and directed-energy weapons, for example, must have target surveillance and acquisition systems, discrimination against decoys, pointing and tracking systems, kill-assessment capability, appropriate weapons and infallible command and control arrangements. In addition, the costs of hypothetical missions remain incalculable. In this respect, a major lesson learned from man's odyssey into space is that the cost of breaking free from the Earth's gravity remains very high.

Removal of suspicion about each other's intentions is in the mutual interest of military Powers with known space-based military capabilities. Several new technologies have already made it possible to use remote sensors for promoting confidence among space-based military Powers and for facilitating the conclusion of several types of arms control agreements.

Materials technology

Materials technology is a product and process enabling technology concerned with the intrinsic and fundamental nature of materials, their response to external stimuli and their properties and characteristics when exposed to a host of environmental conditions. Many of the current advances in materials technology are based largely on processes that affect and generate totally new properties and characteristics rather than the discovery of new materials.

An area of particular interest to new materials technologies is the construction of materials for both high and low temperature use. The high-energy density of emerging magnetic materials is revolutionizing the way in which electro-mechanical and electromagnetic equipment is being designed. Advanced weaponry, space defence and satellite communications systems requiring rapid data storage and retrieval capability will depend upon new materials-enabling technologies.

Military and aerospace applications are also driving the new materials technology to acquire the means for providing high-temperature oxidation resistance.

The use of composite materials as a fuel-efficient and low-weight replacement for aluminium and other metals in jet aircraft has gained some acceptance both in the commercial and the military segments of the aerospace industry. When properly treated, some high-strength, lightweight plastic materials can offer twice the strength and half the weight of aluminium.

Today, the nature of materials affects the lethality of weapons, the survivability of troops, the performance of aircraft, the costs of production of new systems and every aspect of every component of defence equipment. Efforts at improving the performance of weapons may result in a search for new materials that offer benefits over the old, in capability, ease of manufacture or cost. Future development in materials may also offer designs not previously possible.

In regard to the military implications of new technologies, materials technology seems to be a crucial area. In the construction of weapon platforms, new materials will allow aircraft to fly faster, tanks to survive attacks better, ships to stay longer at sea, and submarines to range farther.

Information technology

Based as it is upon a cluster of interrelated innovations in microelectronics, computers and telecommunications, information technology is extraordinarily pervasive. It underpins advances in materials, space, nuclear and biotechnologies, yet is itself dependent only on materials. All major technologies are heavily dependent on information in their research, management and control systems, to such an extent that information is sometimes singled out as being at the centre of the present wave of technological change.

Information technology is moving very fast. The theme throughout this area of technology is one of cheaper, faster, physically smaller devices handling vastly more information in many different formats and from many different sources.

Described sometimes as an effective force multiplier, information technology could bring about further dramatic developments in the military sector, which has always been a leading user of advanced technologies.

The use of advances in information technology by the military sector could bring about significant increases in the efficiency of reconnaissance and communications, and could confer greater accuracy on the performance of existing weapon systems. Technologies for military applications could include (a) greatly improved sensors of several types, capable of discriminating faint signals against cluttered backgrounds; (b) vastly improved command, control, communications and intelligence systems that could make possible more flexible and tactically effective use of military forces; and (c) extremely accurate weapons, particularly anti-tank systems, capable of locating and tracking their targets autonomously. Eventually, the use of advanced computers and software systems could also permit the application of artificial intelligence to military systems.

Not only are the new information systems composed of hundreds of important components but their operational potential can be varied fundamentally by interchanging small components.

The role of information technology in contributing to confidence-building and verification issues is widely recognized. Cheaper communication and cheaper, faster computation capacity are not essential for the monitoring of underground explosions, but together with more automated preliminary analysis, they decrease the cost of comprehensive monitoring. In so far as chemical and biological weapons verification

is assisted by analysing movements of materials and equipment, for example, for containment in electronic data bases, information technology has a role to play.

Biotechnology

Biotechnology is the utilization of living organisms and/or their constituents and products for medical, agricultural, industrial and research purposes. It encompasses a number of more or less independent though interrelated complexes of methods such as genetic engineering, protein engineering, cell technology and immune technology.

Currently, advances in protein engineering represent the second wave of the revolution in biotechnology. The first phase was the advent of genetic engineering in the 1970s, when scientists developed methods for extracting individual genes from mammalian cells and inserting them into micro-organisms such as bacteria. The new technology takes genetic engineering one step further, by making changes in the amino-acid structure of the proteins themselves.

At present one of the major effects of biotechnology is in basic and applied biological research. The greater part of these insights contribute to practical consequences in health care, agriculture and environmental protection.

As in the past, current advances in biotechnology are also accompanied by some concern about possible risks and deliberate misuse. Ecological hazards caused by the release of genetically engineered organisms into the environment, genetic manipulation and human cloning, and development of biological and toxin warfare agents are among some of the persistent concerns associated with biotechnology.

Although biological warfare was waged with limited and inglorious success on a few isolated occasions prior to the Second World War, there is no proven recent interest in the military utility of biological warfare agents.

The development, stockpiling and acquisition of harmful biological agents for hostile purposes or in armed conflict are prohibited under the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction (the "biological weapons Convention") of 1972 (General Assembly resolution 2826 (XXVI, annex). Well over a hundred nations of the world, including the United States and the Soviet Union, are parties to the Convention.

Biotechnology is a relatively young science with a vast potential. The developments in biotechnology, for the most part, are likely to be driven by the needs of the civilian sector. Biotechnology may also be applied directly in arms control activities. The most promising application at this time relates to sensors. Thus, proven sensor techniques (such as chromatography, mass spectra, optical beams, and radio-immuno assay) could be used to verify compliance with the chemical weapons convention, while biosensors and monoclonal antibodies are being developed to be the heart of ultra-sensitive and highly specific detectors useful in verifying compliance with the biological weapons Convention and detecting and quantifying pollutants in the air and water.

Looking ahead

In his conclusion to the report, the Secretary-General points out that compared with the spectacular results of preceding decades, the current wave of technological change is mostly evolutionary and largely incremental. Furthermore, it is even more evident that much technology with military application has a dual nature. Military applications independent of civilian research are less common now than earlier when civilian spin-offs from military research were better known. In the modern weapon systems, more improvements are taking place in the field of supporting technologies than in the weapons themselves. Some of these supporting technologies are also helpful in verifying agreements on arms limitation or in other similar functions that promote peace and security.

The Secretary-General's report also states that greater predictability and the removal of speculative uncertainty about technological advances can be achieved by encouraging the present trend towards more openness and greater transparency in military-related matters. The report finds further that in order to develop a realistic set of criteria for technology assessment, the international community needs to be better equipped to follow the nature and direction of technological change. Recognizing that there are already a number of institutions involved in devising and implementing adequate mechanisms for technology assessment, the United Nations can serve as a catalyst and a clearing-house of ideas. Among suggestions already made are several that aim at examining whether new

technologies call into question the existing international agreements on arms limitation or the tacit understandings crucial for adherence to them. An illustrative framework for assessment of "new technologies" could include such criteria as:

- Will they offer new military options either by significantly improving known weapons or by creating new weapons systems?
- What will be their impact on crisis management in peace and during conflict?
- Will they promote better means of verification or weapons disposal?
- Will they create a new set of issues for ongoing negotiations?

Action by the General Assembly

At its forty-fifth session, in 1990, the General Assembly agreed with the Secretary-General's observation that the international community needed to position itself better to follow the nature and direction of technological change. In resolution 45/60, adopted by a vote of 133 to 3, with 16 abstentions, the General Assembly also requested the Secretary-General to continue to follow scientific and technological developments in order to make an assessment of emerging "new technologies" and to submit to the General Assembly at its forty-seventh session, in 1992, a framework for technology assessment taking into account his own report. Furthermore, at the initiative of Germany, the General Assembly unanimously adopted resolution 45/61, in which it

noted, *inter alia*, the contribution of the Sendai Conference of April 1990 to promoting international co-operation in the field of science and technology. It invited all Member States and relevant international organizations to develop international co-operation in this area, with a view to using scientific and technological achievements for disarmament-related purposes, *inter alia* in the fields of verification of compliance by parties with agreements on arms control and disarmament, and application of technologies for weapons disposal. It recommended that the United Nations should give appropriate attention to the collection and dissemination of information on scientific and technological developments in these fields.

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